AN EXPLANATION OF Mr GUNTER's Quadrant,

As it is enlarged with an

ANALEMMA.

BY

RICHARD HOLLAND, Mathemat.

This Book, with all Mathematical Instruments, are Made and Sold by

JOHN PRUJEAN.

Mathematick-Instrument-maker, near *New College*, in Oxon.

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To Rectifie the Quadrant.

1. LAy the String to the day of the month, and put the Bead to the 12 a clock line.

To find the Suns place in the Ecliptick.

2. By the first, rectifie and move about the String till the Bead come to the Ecliptick, and there it sheweth the Suns place, the time of the year being considered.

To find the right Ascension of the Sun.

3. By the first, rectifie and move the String about till the Bead fall upon the Ecliptick, and then the string will shew the right ascension in the Limb of the Quadrant, the time of the year being considered.

For if the Sun be in the Spring Signes, then the right ascension is so much, as it is from the beginning of the Quadrant to the String: But if the Sun be in the Autumn Signes, then the right ascension is so much, as it is from the beginning of the Quadrant, and two Quadrants more.

And if the Sun be in the Summer signes, then the right Ascension is so much as from the end of the Quadrant to the String, and one Quadrant more. But if the Sun be in the Winter signes, then the right Ascension is as much, as it is from the String to the end of the Quadrant, and three Quadrants more.

To find the Amplitude of the Sun.

4. Rectifie and move the String till the Bead fall upon the Horizontal line, and there it sheweth the Amplitude.

To find the Ascensional difference of the Sun.

5. Rectifie, and move about the String till the Bead fall upon the Horizontal line, and then the distance from the beginning of the Quadrant accounted in the Limb to the String is the Ascensional difference.

Hence to get the time of Sun rising to a minute of an hour.

6. Turn the Ascensional difference into time, accounting every 15 degrees thereof for one hour, and every odd degree for 4 minuts of an hour, (that is multiply the odd degrees by 4, to make them minuts) and if the Sun be in the spring, or summer signes, account the time found, before 6 in the morning; but in autumn or winter account it after 6 in the morning.

To

To get the time of Sun rising and Sun setting, yet more grossly.

7. Rectifie, and move the string to that side of the Quadrant next the line of Declination, and there the Bead falleth on the hour.

To find the Declination of the Sun.

8. Rectifie, and move about the String to the line of Declination, and there the Bead falleth on the degree of Declination, and if the Sun be in the spring or summer signes, the Declination is North, but if the Sun be in the autumn or winter signes, the Declination is South.

To get the Latitude of the place where you are.

9. First, get the Declination of the Sun by the 8. Proposition, and consider wherher it be North or South, upon the day you will make observation, and then take the Meridian Altitude of the Sun, and if the Declination thereof be North, take it from the Meridian Altitude to leave the Complement of Latitude; but if the Declination be South, then add it to the Meridian Altitude, to make up the Complement of Latitude, which Complement being had, take it from 90 degrees, the remain is the Latitude desired.

To

To get the hour of the day.

10. Rectifie, and hold the Quadrant ſo, that the Sun beams may paſs through the Sight-holes of the Quadrant, and then the Bead falleth on the hour.

To get the Azimuth of the Sun.

11. Rectifie, and take the preſent Altitude of the Sun, then account the ſame Altitude from the end of the Quadrant, and there lay the String, ſo ſhall the Bead ſhew the Azimuth among the Azimuth lines.

To get the Suns Altitude at any hour of the day.

12. Rectifie, and carry the String about till the Bead fall upon the hour given, and the String ſheweth the Altitude in the Limb, being reckoned from the beginning of the Quadrant.

To find the Altitude of the Sun when he commeth to the true Eaſt or Weſt.

13. Rectifie, and lay the Bead on the Eaſt and Weſt line, and ſo the String ſheweth the Altitude in the Limb, being reckoned from the end of the Quadrant.

To find the time when the Sun cometh to true East or West.

14. Rectifie, and carry about the String till the Bead fall upon the East and West Line, then so many degrees of the Limb as the String wanteth from the end of the Quadrant, let be accounted from the beginning of the Quadrant, and lay the String there, , so the Bead falleth upon the hour.

To get the time of Day-break, (if any be.)

15. Rectifie, and lay the String to 18 Degrees from the beginning of the Limb, and so the Bead shall fall upon the hour of Day-break, in the hour lines of the contrary time of the year, and contrary time of the day.

The use of the Stars scattered in the Quadrant.

They are to find the hour of the Night, if any of them appear, when the Northern Stars of the Nocturnal happen to be obscured.

☞ Where Note, that each of these Stars have a Figure before it, which referreth to one of the Denticles on the edge of the Nocturnal, where those Stars are to be used, and those Denticles are put on according to the right ascension of those Stars.

The

The Use of the Scattered Starrs followeth.

16. Rectifie the Bead to the Star, that is, lay the String to the Star, and put the Bead to the Center of the Star, and then see the Star through the Sights, and observe where the Bead falleth among the summer hour lines, and if the Star which you observe be towards the East, then you must reckon by the Morning hour, but if it be in the West, then take the hour of the Afternoon; now turn over the Quadrant, and turn about the Nocturnal till the Denticle of the same Star observed doth ly upon the hour which you found on the Quadrant side, and then look for the day of the Month on the edge of the Nocturnal, and it standeth at the hour of the night.

17. Hereby also the hour of the Night may be found; for if any of the same Stars be at the Meridian, and turning the proper Denticle to 12. at Night, then the day of the month will stand at the hour of the night.

Con-

Concerning the Rundle on the back-side of the Quadrant.

THis, containeth two things, *viz.* The *Nocturnal*, and the *Analemma.*

To the Nocturnal pertaineth the Hour Circle on the back-side of the Quadrant, and the Circle of Months on the Limb of the Rundle, and all the Constellations graven within the same; the Pin on which it turneth about representeth the Pole of the world.

The use of it is to find the hour of the night in any place of the North-latitude, thus.

18. Observe some Star of the Nocturnal at the Meridian in the Heavens, and turn the same of the Nocturnal to the line of 12. so shall the the day of the month of the Nocturnal stand at the Hour of Night.

Of the Quadrat.

19. TO get an Accessible Altitude, First measure a distance from the Base, and observe the Summitie through the Sights, and see

see on what part or division of the Quadrat the String falleth; If on 100, then is the measured distance and Altitude of the thing above your eye, equal: If on 50, on the farther side of the Quadrat, or *Umbra recta*; then is your distance double to the height; If on 25, on the same side, then is your distance quadruple to the height; For the proportion is,

As 100,
To the parts cut by the String;
So is the measured distance,
To the height.

But if the String fall on 50, on the nearer side of the Quadrat, or *Umbra versa*, then is your distance but half the height: If on 25, on the same side, then is your distance but one quarter of the height above your eye; For the proportion is,

As the parts cut by the String,
To 100,
So is the distance measured,
To the height.

20. Hence it followeth, That if the ground will permit to take a station at will, then let 50 Foot, Yards, *&c.* be measured, and after observation of the Summitie, take half the number of

of the parts cut by the String on the farther side for the height desired. If 45 be measured then take one quarter of the parts cut, for the Altitude required. This is without any Arithmetical operation: The reason thereof is; seeing that it is as in the first.

As 100,
To the parts cut;
So the distance,
To the height.

Therefore by Alternation of proportion

As 100,
To the distance;
So the parts cut,
To the height.

But seeing that the distance is $\frac{1}{2}$, or $\frac{1}{4}$ of 100, therefore also the height is $\frac{1}{2}$, or $\frac{1}{4}$ of the parts cut.

To get an Inaccessible Altitude.

21. If the height be inaccessible (that is where you cannot measure to the Base) then must you take two Stations both in a right line, with the Base of the thing, and at each Station observe the Summitie, noting the parts cut both on the farther

farther side of the Quadrat, and also measure the distance between the two Stations: Then must you divide 10000 by each number of parts cut at each Station.

For the proportion is

As the difference of the two Quotients,
Is to the distance between the Stations:
So is 100,
To the Altitude required.

And to get the distance, from the nearer Station to the Base of the thing, the proportion is

As the difference between the Quotients,
To the distance between the Stations:
So the lesser Quotient,
To the distance desired.

Of the Analemma.

THis containeth all the lines in the Rundle, not before mentioned in the Nocturnal, *viz.* The Inner Circle being the Meridian of the Analemma, and it is divided into 360 degrees: And all the streight lines drawn therein: The Equinoctial is the middle of the Parallel lines,

and

and passeth through the Center of the Rundle, and the two outer lines of the Parallels, are the two Tropicks, the rest of the Parallels, are the intermediate lines of the Suns declination: The Crooked lines which are drawn over the lines of Declination, are the Hour lines, and at each end are figured with their proper figures: The Line which cutteth the lines of Declination at right Angles, is the Axis, and the ends thereof are the Poles of the Analemma: The moveable Index fastened upon the Pin in the Center, representeth these Five Points, *viz.* The Center of the World: The points of East, and West, and of ♈ and ♎.

To *Rectifie the Analemma.*

Put the Horizon so far under the Pole thereof, as the Pole of the World is elevated in the place where you are.

To find the Amplitude of the Sun.

Rectifie, and observe where the Parallel of the Suns Declination, meeteth with the Horizon, for there it sheweth the Amplitude.

To find the time of Sun Riseing.

Rectifie and observe what Hour line meeteth with

with the Section of the Horizon, and the Parallel of the Suns Declination, and that is the hour.

To find the Hour of the day.

First observe the Altitude of the Sun with the Quadrant, then Rectifie the Analemma, and with your Compasses take the Altitude, from the Center along in the Horizon, and run the Compasses so opened perpendiculat on the Horizon, till the higher foot touch the Parallel of the Suns Declination; and there it meeteth with the hour.

To get the time of Day break, if any be.

Rectifie, and take 18 degrees along in the Horizon, and put one foot of the Compasses to the upper edg of the Horizon, and turn the other downwards and so run them parallel till the lower foot touch the Parallel of the Suns Declination, and there it meeteth with the hour.

To find the continuance of Twilight,
or Crepusculum.

Take the hour of Day-break from the hour of Suns rising, and the difference is the time desired.

To

To find the Ascensional difference in Time.

Take the time of Sun rising from 6, if the Sun be in the North Declination, but if the Sun have South Declination, then take 6, from the time of the Suns rising; and in either case you have the ascensional difference remaining.

Hence the length of the day and night may be found in any Latitude.

Which may be thus done: If the Latitude & Suns Declination be North, then add the ascensional difference to 6, and the total is the Semidiurnal Arch, and taken from 6, leaveth the Seminocturnal Arch. But if the Latitude be North, and the Suns Declinasion be South, then take the ascentional difference from 6, to leave the Semidiurnal Arch, but add it to 6, to make the Seminocturnal Arch.

To get the Declination of the Sun.

Rectifie the Analemma, and find the Meridian Altitude of the Sun by your Quadrant, and take the same Altitude from the Horizon with the Compasses, and being so opened, carry them parallel on the Horizon to the Meridian Circle, and there the higher point meeteth with the parallel of the Suns Declination.

To

To find the Latitude of the place where you are.

First get the Suns Meridian Altitude and Declination, as in the laſt above, and with your Compaſſes take the ſame Altitude from the Center along the Horizon, and ſet one foot of the Compaſſes being ſo opened in that point of the Meridian, where the parallel of the Sun toucheth it on the South part, and bring the Horizon to touch the other foot of the Compaſſes (the Compaſſes being kept perpendicular to the Horizon) & then the North end of the Horizon ſhall ſhew the Poles Altitude.

FINIS.